6. (6 pts) A copper weight is placed on top of a 0.5 kg block of wood floating in water. What is the mass of the copper if the top of the wood block is exactly at the water's surface? 

\[ \rho_{\text{wood}} = 6.0 \times 10^3 \text{ kg/m}^3, \quad \rho_{\text{copper}} = 8.9 \times 10^3 \text{ kg/m}^3 \]

\[ m_{\text{copper}} = \frac{m_{\text{wood}} \cdot \rho_{\text{water}} - m_{\text{water}} \cdot \rho_{\text{copper}}}{\rho_{\text{water}}} \]

\[ = \frac{0.5 \cdot 1000 - m_{\text{water}} \cdot 8.9}{1000} \]

\[ m_{\text{copper}} = 0.333 \text{ kg} \]

7. (6 pts) Shane is using a 3.0 cm diameter hose to fill his round swimming pool of diameter 6.0 m. How long will it take to fill the pool to a depth of 1.2 m if water issues from the hose at a speed of 0.40 m/s?

\[ V_{\text{in}} = V_{\text{out}} \]

\[ A_{\text{in}} (\pi r_{\text{in}}^2) = V_{\text{out}} (r_{\text{out}}^2) \]

\[ V_{\text{in}} = 1 \times 10^{-3} \text{ m}^3 \]

\[ V_{\text{out}} = \frac{1.2 \times 1000}{1 \times 10^{-3}} \text{ sec} \]

\[ = 1200 \text{ sec} \]

\[ \approx 3.33 \text{ hr} \]

\[ \approx 1.4 \text{ days} \]

8. (6 pts) On average, the Achilles tendon is 15 cm long and approximately round with a diameter of 8.5 mm. The tendon was found to stretch 3.7 mm under a 13.4 N load. Calculate the modulus of elasticity (E) of this tendon.

\[ \epsilon = \frac{F}{A} = \frac{13.4}{(0.85)^2 \times 10^{-6}} \]

\[ = \frac{9.57 \times 10^6 \text{ Pa}}{9.6} = 9.87 \times 10^5 \text{ Pa} \]
9. (6 pts) A police car (Smoky) traveling at 70 mph is chasing the Bandit, whose speedometer is broken. The frequency of Smokey’s siren is 912 Hz. The apparent frequency heard by the Bandit is 860 Hz. How fast is he going? Assume the speed of sound in air is 767 mph.

\[
\text{Speed of Bandit} = \frac{\text{Frequency Bandit} \times \text{Speed of Sound}}{\text{Frequency Smokey}} = \frac{860 \times 767}{912} = 697 \text{ mph}
\]

10. (6 pts) Two springs of equal length are suspended in parallel. A 2.5 kg weight is added and the system oscillates in simple harmonic motion. If the stiffness of the springs are 12.0 N/m and 7.0 N/m, what is the period of the system?

\[
\text{Period} = 2\pi \sqrt{\frac{m}{k}} = 2\pi \sqrt{\frac{2.5}{12 + 7}} = 2.28 \text{ sec}
\]

11. (6 pts) Larry the Cable Guy is replacing a coaxial cable (copper wire). To determine the length, he sends a longitudinal pulse down the cable and measures the time for it to return. If it takes 0.15 sec for the pulse to return, how long is the cable? \(E_{\text{copper}} = 110 \text{ GPa, } \rho_{\text{copper}} = 8.9 \times 10^3 \text{ kg/m}^3\)

\[
\text{Velocity} = \sqrt{\frac{E}{\rho}} = \sqrt{\frac{110 \times 10^9}{8.9 \times 10^3}} = 3515.6 \text{ m/s}
\]

12. (6 pts) A ray of light passes from air (n = 1) into a glass prism at an angle of incidence of 35°. If the angle of refraction in the glass is 23.7°, what is the speed of the light in the glass?

\[
v = \frac{c}{n} = \frac{c}{n_\text{glass}} = \frac{c}{\sin \theta_\text{ref}} = \frac{c}{\sin 23.7°} = 2.1 \times 10^8 \text{ m/s}
\]

13. (6 pts) 3 kg of lemonade is initially at 35°C. Determine the amount of ice at 0°C needed to cool the lemonade down to 0°C while melting half the ice.

\[
Q = m_\text{ice} \Delta T
\]

14. (6 pts) The humble Morrison abode (1200 ft^2 wall area) has insulation with an R value of 2 ft^2 hr °F/ BTU. Determine the R-value of insulation that Shane would need to install in series so that the heat loss is limited to 14000 BTU in 3 hours for a 23°F temperature difference.

\[
R_{\text{eff}} = R_1 + R_2
\]

-1 didn’t subtract 2 (5.91)
-2 used extra terms
15. (6 pts) The p-v diagram for the Schelter engine is shown. Determine the amount of work done in one cycle of the Schelter engine.

\[ \text{Work} = \text{area under p-v curve} \]

\[ A = \frac{1}{2} \left( \frac{5}{2} \text{ m}^3 \right) \left( -2 \text{ m} \right) = \frac{1}{2} \left( -2 \times 10^3 \text{ kPa} \right) \]

\[ = 2 \times 10^3 \text{ kPa} \text{ m}^3 \]

\[ = 2 \times 10^3 \text{ kJ} \]

\[ \text{Solution:} 21 \text{ kJ} \]

16. (6 pts) Isaac's 400 kg pet camel is at a temperature of 34°C. The specific heat of a camel is 3480 J/kg·K. The camel has an entropy change of 25000 J/kg. What is the final temperature of the camel?

\[ \Delta S = mc \ln \left( \frac{T_f}{T_i} \right) \]

\[ 25000 \text{ J/kg} = (400 \text{ kg}) \times (3480 \text{ J/kg·K}) \ln \left( \frac{T_f}{34^\circ \text{C}} \right) \]

\[ 1.759 \times 10^3 = \ln \left( \frac{T_f}{34} \right) \]

\[ e^{1.759 \times 10^3} = \frac{T_f}{34} \]

\[ T_f = 312.6 \text{ K} \]

\[ = 39.6^\circ \text{C} \]

17. (6 pts) An electron starts from rest at point A where the potential is 12 kV. The electron travels 0.76 m to point B where the potential is 18 kV. Determine the speed of the electron at point B.

\[ V = \frac{q \cdot \Delta V}{m} \]

\[ \frac{12000 \text{ V}}{-1.6022 \times 10^{-19} \text{ C}} = \frac{(18000 \text{ V})(-1.6022 \times 10^{-19} \text{ C})}{-1.6022 \times 10^{-19} \text{ C}} \]

\[ V_B = 2.11 \times 10^6 \text{ m/s} \]

\[ V_B = 4.59 \times 10^7 \text{ m/s} \]

18. (6 pts) A 12 V potential is applied across a circuit that has 20 µF capacitors. Determine the number of capacitors needed if it is desired to store 8.64 × 10^3 J of energy in the circuit.

\[ C_{eff} = \frac{C_1 + C_2 + C_3 \ldots}{n} \]

\[ U = \frac{1}{2} CV^2 \]

\[ 8.64 \times 10^3 = \frac{1}{2} (20 \times 10^{-6}) n (12)^2 \]

\[ \frac{U}{C} = (20 \times 10^{-6}) \frac{n}{12^2} \]

\[ \frac{1.2 \times 10^4}{C} = (20 \times 10^{-6}) \frac{n}{12^2} \]

\[ \frac{n}{C} = 6 \]

\[ n = 6 \]

19. (6 pts) Determine the current in the circuit.

\[ I = \frac{V}{R} \]

\[ \frac{45}{10 \Omega} = 4.5 \text{ A} \]

\[ \frac{3}{20 \Omega} = 0.15 \text{ A} \]

\[ 1 \rightarrow R \rightarrow 1 \rightarrow 1 \]

\[ I = 4.5 \text{ A} \]

20. (6 pts) A particle with a charge of 8 nC is moving with a velocity of (6i + 4j) m/s moving through a magnetic field of (-3j + 5k) × 10^{-7} T. What is the force on the particle?

\[ F = q (v \times B) \]

\[ = 8 \times 10^{-9} \text{ C} \times \left( 6i + 4j + 0k \right) \times \left( -3j + 5k \right) \times 10^{-7} \text{ T} \]

\[ = 1.6 \times 10^{-15} \text{ N} \]

\[ \text{Solution:} 1.6 \times 10^{-15} \text{ N} \]